From ASI's continuing program of new product development . . .

ASI

ADVANCE SERIES 6040

GENERAL DESCRIPTION

Advanced Scientific Instruments / 8001 Bloomington Freeway / Minneapolis, Minnesota 55420

ADVANCE 6040

ASI presents the *ADVANCE* Series 6040

Introduction

Swift and accurate solutions to specific problems is a common goal of all high speed digital computer users. The *ADVANCE* Series computers from ASI's continuing program of new product development combines the characteristics most wanted and needed by scientific, engineering, and on-line systems users. At each computer system level, *ADVANCE* Series computers provide standard options to meet exact hardware needs.

ASI's 6040 is the high performance member of the *ADVANCE* Series family of computers. It provides all the requirements of a medium size computer and allows expansion internally by means of additional magnetic core memory and input/output channels, and externally with a wide variety of peripheral equipment.

ASI has chosen the series approach to its latest product line for several important reasons. One of the most apparent is the cost savings realized by the modularity of a series of computers which in turn provides a more efficient system at a lower cost to the customer. Another is that with a series of computers, ASI can offer a system that grows with the application. With complete series compatibility, you can order a minimum system with the assurance that as your requirements grow additional features may be added with no interruption in production. This is possible because all programs and routines as well as peripheral equipment are fully upward compatible. Further, if your system needs cannot be met by the computer originally used, the next computer in the series can be installed with no reprogramming or new peripheral equipment costs since all programs and peripheral equipment will run on the new system with no modification.

In addition, ASI equally emphasizes product service. With each system, ASI provides the assistance of a staff of fully trained and experienced people whose purpose is to insure the complete satisfaction of all your requirements. ASI provides total support to engineering and scientific computer users by producing a family of computers whose configurations may be "custom designed" for each application.

Particulars on ASI's 6040, the high performance member of the *ADVANCE* Series computers, are contained in this brochure.

Features

ADVANCE 6040

Flexibility: The capability of being readily adjustable to changing conditions—a most prominent quality of the 6040, the high performance member of the *ADVANCE* Series computers from ASI. Because of the 6040's flexibility, engineering and scientific users of digital computers no longer face the decision of whether to buy more computing power than is necessary in order to get the desired features in a machine or to buy a less capable device and try to make up the deficiency through sophisticated and time consuming programming. In the case of buying more computing power than necessary, the problems presented to the machine will most surely be solved quickly but the cost for each result may be excessively high. On the other hand, using a smaller machine will be less expensive but more time will be required for each result. This restriction may cause the result to be useless, especially in real-time applications.

The *ADVANCE* 6040 does not solve the problem of which computer to buy when this situation occurs — it eliminates it. The minimum configuration of the 6040 contains the basic features desired in nearly all situations. These include:

A 24-bit word length, plus 1 parity bit.
A 1.9 microsecond memory cycle time.
Automatic parity checking of all memory operations.
Parallel operation throughout.
Trapped interrupt.
Direct input/output to or from the accumulator.
Three hardware index registers.
A high speed arithmetic unit (7.6 microsecond multiply and 11.4 microsecond divide).
Sixteen programmed instructions that call subroutines as if they were single instructions.

These features alone make the 6040 an outstanding medium scale computer. The following options put it in a class above any comparably priced product.

Memory expansion up to a directly addressable 32,768 24-bit words. 32 levels of priority interrupt.

A choice of several types of buffered channels are available. Among these are: Character, word, field, and cyclic.

Up to 8 fully buffered input/output channels of any combination of types each with the capability of servicing 16 external devices.

Up to 4096 external sense and control lines.

But the central processor is only a small part of a computing system. To complement the 6040, ASI offers a complete line of proven, dependable, peripheral devices. Magnetic tape units, line printers, card readers and punches, paper tape equipment, input/output typewriters, and incremental plotters. If your problem requires special equipment, ASI will provide total design assistance in order to meet your exact requirements.

Fully tested programming systems are also part of the computing system offered by ASI. Our staff of experienced programmers have developed and field tested a complete library of programming aids which includes a one pass assembler, a one pass compiler and other standard software features. ASI also offers the use of our programming staff to assist you in the programming of your problem.

This combination of an extremely flexible computer, proven peripheral equipment, complete software systems, and a fully staffed and trained support organization makes the *ADVANCE* 6040 Computing System worthy of your closest attention.

Instruction Repertoire

Description	Mnemonic Code	6040 Time Cycles*
TRANSFER OPERATIONS		
Load A	LDA	2
Load E	LDE	2
Load AE	DLD	3
Load Exponent	LXP	2
Store A	STA	2
Store E	STE	2
Store AE	DST	3
Store A Address	SAM	3
Store Exponent	SXP	3
Load Address	LOA	3
ARITHMETIC OPERATIONS		
Add	ADD	2
Double Add	DAD	3
Subtract	SUB	2
Add Address	AOA	2
Add Magnitude	AMA	2
Multiply	MPY	4
Subtract Address	SOA	2
Divide	DVD	6
Add to Memory	ADM	3
Round	RND	2
LOGICAL OPERATIONS		
Logical AND	AND	2
Logical OR	LOR	2
Exclusive OR	XOR	2
SHIFT		
Right Shift A	RSA	Variable
Left Shift A	LSA	Variable
Circular Left Shift A	CSA	Variable
Logical Right Shift A	RLA	Variable
Logical Left Shift A	LLA	Variable
Right Shift E	RSE	Variable
Left Shift E	LSE	Variable
Circular Left Shift E	CSE	Variable
Logical Right Shift E	RLE	Variable
Logical Left Shift E	LLE	Variable
Right Shift AE	RSD	Variable
Left Shift AE	LSD	Variable
Circular Left Shift AE	CSD	Variable
Logical Right Shift AE	RLD	Variable
Logical Left Shift AE	LLD	Variable
Normalize	NRM	Variable
PROGRAMMED INSTRUCTION OPERATIONS		
Programmed Instruction	PIn	3+Sub
TRAP-FLAG OPERATIONS		
Clear Flip-Flops	CTP	2
Set Flip-Flops	STP	2
Save and Clear Flip-Flops	SCT	2
Save and Set Flip-Flops	SST	2

Description	Mnemonic Code	6040 Time Cycles*
INDEX OPERATIONS		
Store Index	SXM	4
Augment Index	AUX	3
Decrement Index Jump	JDX	3
Load Index Address	LOX	2
Load Index A Address	LAX	2
Increment Index & Test	IXT	3
Skip Index High	KXH	2/3
BRANCHING OPERATIONS		
Jump	JMP	1
Disable Interrupt Jump	JDI	2
Jump to M + 1	JPO	2
Return Jump	RTJ	3
Jump if A Less Than O	JLZ	2/3
Jump if A Greater Than O	JGZ	2/3
Jump if A equals O	JEZ	2/3
Skip A Low	KAL	3
Skip A High	KAH	3
Skip A Equal	KAQ	3
Increment Memory Test	IMT	4
Skip Y = O	KOZ	3
Skip Y = 1	KON	3
Skip EXT Signal	KEX	2/3
Conditional Skip	KIF	2/3
REGISTER CHANGE OPERATIONS		
Zero A	ZOA	2
Zero E	ZOE	2
Zero AE	ZOD	2
Clear A to Sign of E	ZSA	2
Complement A	CMA	2
Complement E	CME	2
Complement AE	CMD	2
Minus A	MNA	2
Minus E	MNE	2
Minus AE	MND	2
Absolute A	AVA	2
Absolute E	AVE	2
Absolute AE	AVD	2
Sign of A to E	SAE	2
Sign of E to A	SEA	2
Copy A in E	ATE	2
Copy E in A	ETA	2
Exchange AE	XAE	2
Zero Memory	ZOM	4
INPUT/OUTPUT OPERATIONS		
External Device	EXD	1+CW
External Signal	SEN	3
External Word to A, Skip	XAK	3/4
A to External, Skip	AXK	3/4
Assembly Register	ASR	1+CW
External Word to Memory, Skip	XMK	3/6
Memory to External, Skip	MXK	3/4
OTHER OPERATIONS		
Execute	XEC	1 + cyc
Halt	HLT	—
No Operation	NOP	2

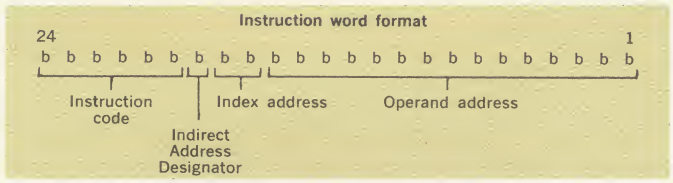
*1 cycle = 1.9 microseconds

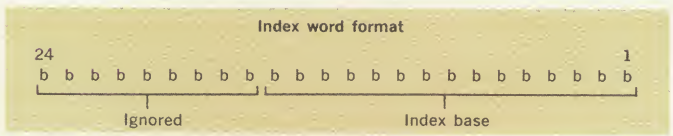
ADVANCE 6040

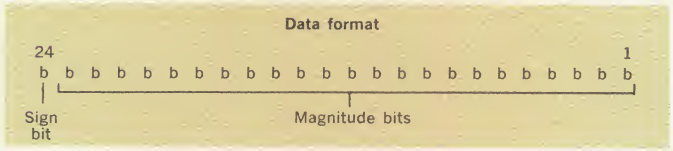
Organization

INSTRUCTION LIST. The phrase that best describes the 6040's instruction list is "completely adaptive." For in the primary stages of design, ASI's programming staff conferred with customers and prospects in order to determine what commands should be included in future machines. Each instruction in the 6040's list is a direct result of this study. However, some applications may require special commands and therefore, as an *ADVANCE* Series option, several codes have been unassigned so that special instructions can be added.

Word Formats:







b = 1 binary digit

PROGRAMMED INSTRUCTIONS. Special subroutines may be used as if they were single commands by employing one of the 16 Programmed Instructions of the 6040's repertoire. This capability allows the programmer to define his own special commands through the use of subroutines, which may be changed by the operating routine if desired. The number of instructions required in a typical program are reduced because each subroutine may be called by a single instruction instead of 2 or 3. Programmed Instructions also provide, with standard ASI recommended subroutines, complete instruction compatibility for all members of the *ADVANCE* Series.

TRAPPED PROGRAM INTERRUPT. Normally any condition that causes an interrupt is desired to be known as soon as possible. In some cases it may be more convenient to ignore this condition. To allow for this possibility, ASI provides interrupt traps which may be armed or disarmed by program control. An interrupt trap is associated with each interrupt event; an interrupt may occur only if its corresponding trap is armed. Any trap may be individually armed or disarmed and its condition may be stored in memory or tested under program control. Seven events may cause an interrupt to occur: (1) Add Overflow, (2) Operator Interrupt Switch, (3) Memory Parity Fail, (4) Power Fail, (5) Programmed Input/Output Channel, (6) Non-priority External Device, and (7) Priority External Device.

CONTROL PANEL. The operator's control panel contains all the switches and indicators for the operation of the central processor. Bit-by-bit register display and manual entry into the registers are provided by convenient indicator pushbuttons. The control panel is used primarily for initial set-up prior to a program run or for debugging purposes rather than to exercise control over a running program. Control of an operating routine is maintained by the use of the on-line typewriter or by sense switches.

INDEX REGISTERS: The three index registers of the 6040 are hardware registers, not reserved locations in memory. Indexing causes no delay in instruction running times. Seven separate commands—load index, store index, increment index, augment index, and test index and jump decrement index—allow full utilization of the register's capabilities.

ARITHMETIC. The 6040 uses the signed magnitude number system with a two's complement binary adder. The sign bit (Bit 24) is a 0 for positive numbers and a 1 for negative numbers while the remaining bits (Bits 1-23) represent the magnitude of the number. The magnitude bits are the same for both positive and negative numbers. This feature provides a convenient method of representing negative numbers.

DOUBLE PRECISION HARDWARE. Application problems that require a high degree of precision are easily and quickly solved by the 6040 because of its double precision hardware. By using a word size of 48 bits rather than the ordinary 24, the precision of both fixed and floating point operations is considerably greater. The double precision store, load, and add instructions provide swift completion of all double precision operations.

ON-LINE TYPEWRITER. The on-line typewriter, a standard feature of the 6040, provides monitor control of operating programs. It operates on a character at a time basis under program control and communicates directly with the 6040's accumulator. Data communication is through the programmed input/output channel.

PRIORITY INTERRUPT. Only a priority interrupt can interrupt a non-priority interrupt routine. Power fail is the highest priority interrupt and may interrupt any other program or interrupt routine as long as the power fail interrupt trap is armed. Memory parity fail is the second highest priority interrupt and may interrupt any program or interrupt routine except power fail or another memory parity fail interrupt routine. Up to 32 external device priority interrupts, each with a distinct level of priority, are optional in groups of four. Each priority interrupt may be separately accepted or rejected under program control or all priority interrupts may be rejected by clearing the priority interrupt trap.

MEMORY. The 6040 memory has been designed to provide a total memory cycle time of 1.9 microseconds. The basic size of 4,096 24-bit words (plus 1 parity bit) may be expanded in modules up to 32,768 directly addressable locations. An automatic circuit in the memory system performs a parity check on all memory data. A parity fail interrupt will occur whenever a parity fail is detected and the memory parity fail trap is armed.

PROGRAMMED INPUT/OUTPUT

Program control of information transfer between the central processor and an external device provides the fastest method of operating on data received from peripheral equipment. The 6040's programmed input/output channel allows input directly to the accumulator where the data can be acted on immediately, or to the memory for storage. Likewise, output data may be sent directly from the accumulator or from the memory to an external device.

BUFFERED INPUT/OUTPUT

ASI offers 8 types of fully buffered input/output channels as options to the basic 6040 computer.

Character Channel
: Transmits or receives 4 6-bit characters per computer word. Performs all assembly and disassembly automatically. (Capable of average character rate over 230 kc)

Word Channel
: Transmits or receives 1 24-bit word per computer word. No assembly or disassembly occurs. (Over 175 kc word rate)

Field Channel
: Transmits or receives 6-bit characters in the same manner as the character channel but allows convenient communication of variable-length character fields. (Capable of average character rate over 230 kc)

Cyclic Channel
: Transmits or receives words in the same manner as the word channel but cyclic communication with a string of blocks in memory may continue indefinitely without program attention. (Over 175 kc word rate)

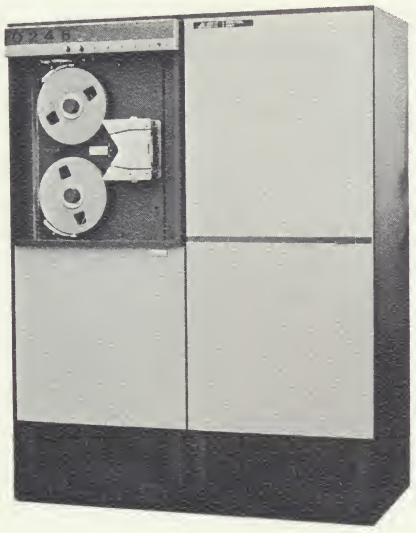
EXTERNAL SENSE AND CONTROL LINES

Up to 4,096 sense lines are available as *ADVANCE* Series options to the 6040. These lines can be used to inform the central processor of the condition of any two-level possibility such as: switch on or off, temperature normal or abnormal, voltage in regulation or out, etc. Another 4,096 lines may be used for control purposes, each capable of providing a two-level control signal to any external device. Typical applications include: turn indicating lights on or off at remote areas, control of relays in special equipment, initiation of analog sequences, etc.

ADVANCE 6040

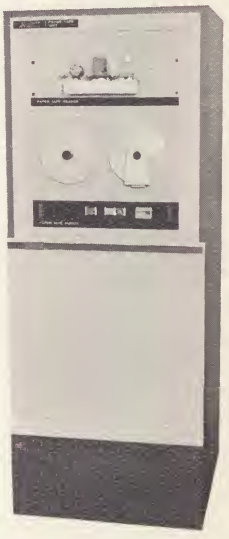
Peripheral Equipment

The peripheral equipments shown here are designed to be compatible with *ADVANCE* Series 6040 both in style and operation. Increasing the efficiency, versatility, and flexibility on the 6040, these external devices increase the usefulness of the system.

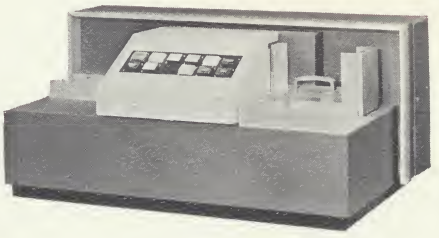


Magnetic Tape Units. Tape units are available to provide either low or high density operation. IBM 729 compatibility permits the use of tape written in this accepted format. Other features include lateral and longitudinal parity checks, several character transfer rates, high-speed manual rewind and fast forward, multiple record search in either direction, no program restrictions, conversion from ASI alphanumeric to IBM codes to facilitate preparation of compatible tape, and multiple tape drive operation from one control unit.

Line Printer. The line printer prints 400 lines per minute alphanumeric, 120 columns wide with the standard 48-character drum. It will print anywhere on a horizontal 12-inch portion of a 17-inch line. The vertical format is controlled by an 8-level punched tape loop which may be easily substituted by other loops for vertical format flexibility.



Paper Tape Unit. This unit consists of a separate high-speed reader and a punch. The reader will read either 5-, 6-, 7-, or 8-level punched tape at a rate of 300 characters per second, while the punch will punch 8-level tape at 60 characters per second.



Punch Card Control Units. These units contain all logic, control and power electronics to make card formats compatible with 6040 formats. One unit is for use with an 800 card-per-minute reader and a 250 card-per-minute punch, while the other unit has a self-contained 200 card-per-minute reader and operates a 100 card-per-minute punch.

Digital Incremental Plotters. Digital incremental plotters are available in four models that offer varied paper size, speeds, and plotting increments. Since the control unit does not require the use of a computer I/O channel, simultaneous plotting and other I/O operations on the same channel are possible.

Special Peripheral Units. Specially designed peripheral units including Analog-to-Digital and Digital-to-Analog Control units increase the versatility of the 6040 by permitting communication with non-digital and "foreign" equipment, thus expanding the user's applications to include on-line and systems control.

ADVANCE 6040

Support

It is the user's desire to get the most out of his computer system as possible, and ASI's Support Program is designed to help you, the user, meet this goal. Not only does the Support Program assist you before, during, and after purchase, but covers the design of the computer system including any special interfacing required. It is the aim of the Support Program to be as complete as possible; to help you in every way. The main features of the Program are as follows:

Pre-purchase Assistance. ASI will meet with your personnel to evaluate your unique problem. Then, a total solution to this problem will be proposed. Included will be the 6040, the options, the peripheral equipment, any special devices, and the software necessary to do the job most efficiently and economically as possible. From the simplest computer installation to a large and complex on-line system, ASI is equipped to design the entire system. You benefit from years of experience and have the assurance that your system will represent the most effective integration of the system's various components.

System Interface Design. For unique user applications, such as on-line installations which require specialized input/output equipment, ASI's Engineering Staff will design the necessary interface units as part of ASI's service to their customers. Then, ASI will fabricate these units, at a normal product cost, for your particular system under close supervision by the same engineers that designed them. These engineers, who are naturally quite familiar with the logic and requirements of the 6040, ar best qualified to do this important work.

ASI Total System Responsibility. ASI may be contracted to be responsible for the design and installation of all standard and special external devices in the system. One responsibility for the entire system reduces confusion you will have with multiple contractors as well as the confusion between these contractors and the requirements of their various components. The entire system, or as much of it as practical, will be set up and thoroughly tested prior to shipment to your site to assure you it is operational. Let ASI co-ordinate the entire job.

Installation. ASI will be on-site to help with the installation of the equipments. Special attention will be given to the installation of interfacing hardware designed to be used with "foreign" devices. This assistance relieves you of any worry about the proper mating of these two types of hardware. After installation, it will be checked-out to assure you the system is operational. Testing of your particular program and other software by field applications analysts will complete the installation of your system. For highly complex systems, factory programming experts will be on hand for this important phase of installation.

Operator and Programmer Training. Training courses in programming the 6040 and in FORTRAN II and the Symbolic Assembler are available to your programmers. Also, courses are offered to operators in the use of the 6040 and to company management in the most efficient use of their computer system. After installation, classes in advanced systems are made available as well as a programmer's workshop.

Post-purchase Assistance. Assistance to you from ASI continues even after purchase. Trained field applications analysts are available to you on a local level to aid you in the daily running routine of the system and in developing new programs. Factory systems support is available to you from Engineering to modify or expand the hardware in your system, from Applications to find new uses for your computer system, and from Programming to aid you in setting up advanced, complex programs. These services are always available to you whenever you may need them.

User's Group. This organization, made up of users of ASI Computing Systems and sponsored by ASI, provides users an opportunity to share knowledge they have gained in using a digital computing system and exchange programs they have developed.

Maintenance. ASI's staff of competent service personnel, located throughout the country, is available for on-call maintenance of computer hardware at all times. Software maintenance in the form of improvements and additions will be brought to your attention whenever they occur.

ADVANCE 6040

Software

A computing system is only as good as its software. ASI provides a complete software package with the *ADVANCE* Series 6040 which includes a one-pass FORTRAN II Compiler, a one-pass Symbolic Assembler, plus related routines and subroutines. This package insures the user ease of programming.

One-Pass FORTRAN II. The new ASI one-pass complete FORTRAN II Compiler includes subroutine and function statements, arithmetic function statements, and Boolean algebra statements. The one-pass feature provides output in machine language binary from the FORTRAN II program input. "Program Chaining" permits programs whose size exceeds that of the memory in your particular 6040 to be run in segments with one magnetic tape unit.

One-Pass Symbolic Assembler. The new one-pass Symbolic Assembler is an assembly program which permits the use of standard macro coding of such functions as floating point routines and input/output routines. Special features of the Symbolic Assembler include pseudo codes such as ENTRY, COMMON, and LINK which permit flexible linkage, data sharing among subroutines, and program overlay. The Symbolic Assembler provides for the acceptance of source program from cards, paper tape, and magnetic tape. Naturally, such assembler directing codes as RES, OCT, DEC, EQU, ORG, etc., are provided.

Executive Routine. This is a monitor program which allows for the centralized control of program operation. It provides a load-and-go operation without operator intervention with one magnetic tape unit. The operator can specify loading and execution of any program on the master system tape by a simple on-line typewriter directive.

Mathematical Subroutines. ASI provides a complete set of mathematical subroutines including SINE, COSINE, SQ ROOT, EXPONENT, LOG, etc.

Utility Routines. A number of routines allowing tape reproduction, conversion of cards to tape and tape to cards, memory dump, paper tape updating, etc., are also available.

Diagnostic Routines. Diagnostic routines covering both program and hardware checking are available.

ASI

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From ASI's continuing program of new product development . . .

ASI

ADVANCE SERIES 6020

GENERAL DESCRIPTION

Advanced Scientific Instruments / 8001 Bloomington Freeway / Minneapolis, Minnesota 55420

ADVANCE 6020

The *ADVANCE* Series 6020 . . . from ASI's continuing product development program—

Introduction

The **new** 6020 from the **new** *ADVANCE* Series family of computers is the heart of a low-cost system for the small scale user. It is ideally suited to a wide range of applications, including scientific and engineering computations, on-line systems control, and data reduction. Designed to satisfy small scale computer needs, the 6020 permits expansion both internally with additional magnetic core memory and input/output channels, and externally with a wide variety of peripheral equipment.

This flexibility permits you, the user, to select your own configuration, utilizing only those features which are necessary to you at the time. However, as your needs grow, so can the 6020. The wide variety of both standard and custom designed peripheral equipment offered by ASI allows you to utilize your 6020 System to the maximum, which further reduces the already low cost per answer ratio. The 6020 System expands only as required and in the direction required. There are no gaps; no useless pieces of equipment.

However, the time may arise when you completely outgrow your 6020 and require a larger computer. The change from the 6020 to the next larger computer in the *ADVANCE* Series causes no confusion or loss of time. All programs for the 6020 will operate without change on other computers in the *ADVANCE* Series; all peripheral equipment used with the 6020 will operate with other computers in the *ADVANCE* Series. Therefore, the growth pattern of your system can be logical and efficient.

ASI's services are user-oriented. Through its Engineering Staff, ASI offers complete systems design assistance to give you the most efficient system possible. After the design has been completed, ASI, if contracted, will carry on with total system responsibility, taking full charge of installing the complete system.

Pre-delivery support includes programming and operator training courses, user program testing, and management planning assistance. After delivery, programming assistance continues and trained staffs of maintenance engineers located throughout the country are available for local service.

The *ADVANCE* Series is more than hardware . . . it is an all-inclusive program with you at the focal point. From the tried and proven software package to the information-sharing User's Group, the aim is to make the ASI Computing System as useful a tool for you as possible for as long a time as possible. What better place to start than with the *ADVANCE* Series 6020?

Outstanding Features

4,096 24-bit (plus parity) Word Memory. Expandable to 32,768 words. All directly addressable.

Speed. A total memory cycle time of 1.90 microseconds.

Double Precision Hardware. A subroutine is not required to handle double-precision operations. Execution time and memory storage needs are reduced and accuracy is increased over single-precision arithmetic.

Memory Parity check is automatically made on all memory data.

Sixteen Programmed Instructions call subroutines, providing parameter and return addresses with one instruction.

Three Index Registers may automatically modify the operand address.

Successive Indirect Addressing with indexing at each step.

Multilevel Interrupts. As another option of the *ADVANCE* Series, the 6020 may have 32 individual levels of priority interrupts which permits a higher priority routine to interrupt a lower priority routine.

ASI "Preset". Data from an external device (such as a paper tape reader) can be loaded into the memory with a simple console manipulation.

64 Individual Addresses for External Interrupts. These addresses are used for control interrupts (real-time requirements, completion of data communication, or failure) from external devices. Each address can lead to a separate subroutine. These control addresses are NOT required for data transfer between the central processor and the external device.

Special Interrupts can interrupt the program for an add overflow, operator selected interrupt, programmed I/O channel, memory parity error, or power failure.

Programmed Input/Output Channel. Permits convenient program handling of word or character information from external devices. Up to 16 external devices may time-share this channel.

Input/Output Typewriter. Standard with the 6020, it provides monitor control of operating programs.

Internal and External Traps. Under program control, external or internal interrupts can be independently accepted or rejected.

Repertoire. Over 120 instructions. Sixteen definable programmed instructions which may be assigned to specific subroutines to optimize the solution of special problems.

Additional Buffered Channels. Character Assembly, Field Length, Complete Computer Word, and Cyclic are among the I/O channels offered by ASI that may be added to the 6020. Up to 16 external devices may be connected to each buffered input/output channel for more efficient use of the channels.

Fast Input/Output Rate of 230,000 characters per second (buffered Character Channel) of 175,000 words per second (buffered Word Channel).

Complete Batch Processing permits automatic sequential running of various programs without operator intervention. Requires 8K memory and one magnetic tape unit.

External Sense and Control Lines (Optional). Up to 4,096 lines to sense any two-level conditions such as on and off, pressure correct or not, overload, etc. Also, 4,096 control lines providing a two-level control signal to any external device for indicator lights, relay control, sequence initiation, stepping switch operation, etc.

Minimum Site Preparation Requirements. The 6020 is designed to operate at normal room temperatures and humidity. Subflooring construction for cabling is not required. Special cabinet design permits the positioning of equipment in most installations in a manner which completely eliminates unsightly cables and dangerous raceways.

Instruction Repertoire

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Store A	STA	2
Store E	STE	2
Store AE	DST	3
Store A Address	SAM	3
Store Exponent	SXP	4
Load Address	LOA	3
ARITHMETIC OPERATIONS		
Add	ADD	2
Double Add	DAD	6
Subtract	SUB	2
Add Address	AOA	2
Add Magnitude	AMA	2
Multiply	MPY	16
Subtract Address	SOA	2
Divide	DVD	25
Add to Memory	ADM	4
Round	RND	2
LOGICAL OPERATIONS		
Logical AND	AND	2
Logical OR	LOR	2
Exclusive OR	XOR	2
SHIFT		
Right Shift A	RSA	2 + k
Left Shift A	LSA	2 + k
Circular Left Shift A	CSA	2 + k
Logical Right Shift A	RLA	2 + k
Logical Left Shift A	LLA	2 + k
Right Shift E	RSE	2 + k
Left Shift E	LSE	2 + k
Circular Left Shift E	CSE	2 + k
Logical Right Shift E	RLE	2 + k
Logical Left Shift E	LLE	2 + k
Right Shift AE	RSD	2 + k
Left Shift AE	LSD	2 + k
Circular Left Shift AE	CSD	2 + k
Logical Right Shift AE	RLD	2 + k
Logical Left Shift AE	LLD	2 + k
Normalize	NRM	6 + k
PROGRAMMED INSTRUCTION OPERATIONS		
Programmed Instruction n = 1–16	PIn	3+Sub
TRAP-FLAG OPERATIONS		
Clear Flip-Flops	CTP	2
Set Flip-Flops	STP	2
Save and Clear Flip-Flops	SCT	2
Save and Set Flip-Flops	SST	2

Description	Mnemonic Code	6020 Time Cycles*
INDEX OPERATIONS		
Store Index	SXM	4
Augment Index	AUX	4
Decrement Index Jump	JDX	4
Load Index Address	LOX	2
Load Index A Address	LAX	2
Increment Index & Test	IXT	4/5
Skip Index High	KXH	2/3
BRANCHING OPERATIONS		
Jump	JMP	1
Disable Interrupt Jump	JDI	2
Jump to M + 1	JPO	2
Return Jump	RTJ	3
Jump if A Less Than 0	JLZ	2/3
Jump if A Greater Than 0	JGZ	2/3
Jump if A equals 0	JEZ	2/3
Skip A Low	KAL	4
Skip A High	KAH	4
Skip A Equal	KAQ	4
Increment Memory Test	IMT	4
Skip Y = 0	KOZ	4
Skip Y = 1	KON	4/5
Skip EXT Signal	KEX	2/3
Conditional Skip	KIF	2/3
REGISTER CHANGE OPERATIONS		
Zero A	ZOA	2
Zero E	ZOE	2
Zero AE	ZOD	2
Clear A to Sign of E	ZSA	2
Complement A	CMA	3
Complement E	CME	3
Complement AE	CMD	3
Minus A	MNA	2
Minus E	MNE	2
Minus AE	MND	2
Absolute A	AVA	2
Absolute E	AVE	2
Absolute AE	AVD	2
Sign of A to E	SAE	2
Sign of E to A	SEA	2
Copy A in E	ATE	2
Copy E in A	ETA	2
Exchange AE	XAE	2
Zero Memory	ZOM	4
INPUT/OUTPUT OPERATIONS		
External Device	EXD	1+CW
External Signal	SEN	3
External Word to A, Skip	XAK	3/4
A to External, Skip	AXK	3/4
Assembly Register	ASR	1+CW
External Word to Memory, Skip	XMK	3/6
Memory to External, Skip	MXK	3/4
OTHER OPERATIONS		
Execute	XEC	1 + cyc
Halt	HLT	—
No Operation	NOP	2

*1 cycle = 1.9 microseconds

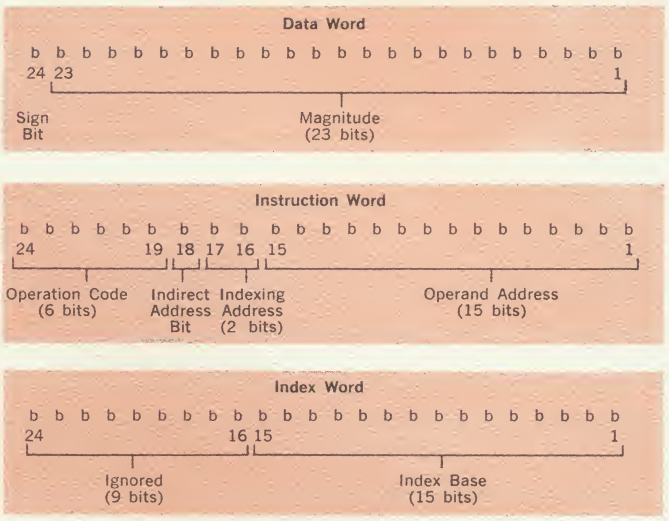
ADVANCE 6020 Central Processor Organization

The *ADVANCE* Series 6020 is composed of three sections: Arithmetic and Control, Input/Output, and Memory. The Arithmetic and Control Section calculates, routes information, and controls the other sections of the central processor. The Input/Output controls peripheral equipment operation and handles all data going in and out of the central processor. Memory, whose total cycle time determines the overall speed of the central processor, provides storage of data and instructions.

Arithmetic and Control Section

The Arithmetic and Control Section uses the signed magnitude number system with a "one's" complement binary adder. The sign bit (Bit 24) is a "0" for positive numbers and a "1" for negative. The remaining 23 bits represent the magnitude of the number, and are the same for both a positive and negative number of the same magnitude. This system permits easier program debugging by the user.

Word Formats:



b = 1 binary digit

Indirect Addressing. Successive indirect addressing with indexing at each step may be performed with the 6020.

Programmed Instructions. Special subroutines may be used as if they were single commands by employing one of the 16 Programmed Instructions of the 6020's repertoire. This capability allows the programmer to define his own special command, through the use of subroutines, which may be changed by the operating routine if desired. It also provides, with standard ASI recommended subroutines, complete instruction compatibility for all members of the *ADVANCE* Series.

Index Registers. The three index registers, which utilize unique locations in memory, can be used for storing data, holding commands, and participating in arithmetic operations as well as for their primary function of modifying addresses. The availability of several index registers reduces the programming time in many scientific and engineering problems.

Trapped Program Interrupt. Events can cause the program of the computer to be interrupted: (1) Memory Parity Error, (2) Add Overflow, (3) Programmed I/O Channel, (4) Operator, (5) External Device, (6) Multilevel Priority Interrupts, and (7) Power Failure. An interrupt trap associated with each event may be set under program control to either respond when the event occurs or to ignore it.

Sixty-four addresses in memory are reserved for External Device interrupts (Event 5 above). Each interrupt occurs at its own address so that it can lead to its own unique subroutine. Upon completion of the subroutine, control can be returned to the original program at the point of interruption.

Operator Indicators. The two independent operator indicator lights may be used to call the operator's attention to any conditions that the programmer desires. They can be set, cleared, and tested under program control to fulfill the varying requirements of different programs.

Sense Switches. The six sense switches on the operator's console provide manual control of program branching. Testing of the sense switch settings occurs when the sense switch instruction is given.

Input/Output Section

Programmed Input/Output Channel. Program control of information transfer between the central processor and an external device provides the fastest method of operating on data received from peripheral equipment. The 6020's programmed input/output channel allows input directly to the accumulator, where the data can be acted on immediately, or to the memory for storage. Likewise, output data may be sent directly from the accumulator or from the memory to an external device.

Buffered Input/Output Channels. The 6020 is supplied with one buffered I/O channel which will accommodate up to 16 external devices. A variety of buffered channels may be added, up to a total of eight. Each buffered I/O channel has its own associated registers. Two or more buffered channels increase the processor's efficiency by permitting simultaneous input/output operations. Also, up to 64 additional external devices can be accommodated with this arrangement (2 or more buffered channels).

Buffered input/output channels permit the central processor to continue with computation while input and output communications are proceeding. Access to the memory is time-shared between the operating program and input/output data transfer. Access also is automatically controlled by the I/O rate of the external device; it is not a programming consideration. Any cycle of the memory time is available for input/output data transfer in preference to its use by the program.

The most commonly used buffered input/output channel is the character channel, which sequentially transmits 6-bit bi-octal or alphanumeric characters. These characters are automatically assembled or disassembled into 24-bit computer words by an I/O assembly register. In addition, the buffered I/O channel is provided with two 15-bit address registers. These registers define the beginning and limit locations in memory into or from which a block of data (record) is to be transferred, thus permitting records of various lengths.

Additional buffered I/O channels are available. The Word Channel will transmit the entire 24-bit word at one time. A Field Channel permits the sequential storing in memory of "foreign" words of variable length. The Cyclic Channel transmits words in the same manner as the Word Channel, but may continue communication with a block in memory indefinitely without program attention.

Optional Multilevel Priority Interrupts. Interrupt provisions have been made to facilitate the priority requirements of various subroutines. The interrupt requests of these subroutines are handled by the central processor in the sequence of highest priority. If a priority subroutine requests an interrupt, it will have priority over all subroutines of lower priority, even though they have previously requested an interrupt.

Optional External Sense and Control Lines. Up to 4,096 sense lines are available to test the two-level state of any on-line equipments. They might be considered as remote Sense Switches, as they operate in the same manner. Also, up to 4,096 control lines are available to operate any two-level or pulse operated device.

Memory Section

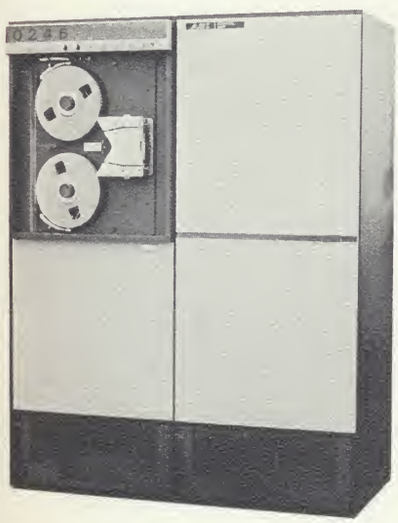
Many of the significant features of the 6020 are a result of its fast memory which has been designed to provide a total memory cycle time of 1.90 microseconds. Memory words contain 24 bits plus a parity bit. Memory word parity is generated on all write operations and checked on all read operations.

The basic memory size is 4,096 25-bit (including parity) words. However, it is expandable in modules to a maximum size of 32,768 words. All 32,768 words are directly addressable.

ADVANCE 6020

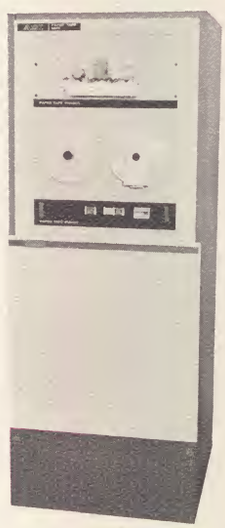
Peripheral Equipment

The peripheral equipments shown here are designed to be compatible with *ADVANCE* Series 6020 both in style and operation. Increasing the efficiency, versatility, and flexibility of the 6020, these external devices increase the usefulness of the system.

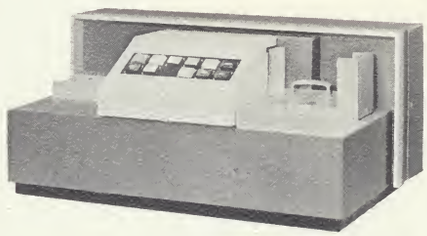


Magnetic Tape Units. Tape units are available to provide either low or high density operation. IBM 729 compatibility permits the use of tape written in this accepted format. Other features include lateral and longitudinal parity checks, several character transfer rates, high-speed manual rewind and fast forward, multiple record search in either direction, no program restrictions, conversion from ASI alphanumeric to IBM codes to facilitate preparation of compatible tape, and multiple tape drive operation from one control unit.

Line Printer. The line printer prints 400 lines per minute alphanumeric, 120 columns wide with the standard 48-character drum. It will print anywhere on a horizontal 12-inch portion of a 17-inch line. The vertical format is controlled by an 8-level punched tape loop which may be easily substituted by other loops for vertical format flexibility.



Paper Tape Unit. This unit consists of a separate high-speed reader and a punch. The reader will read either 5-, 6-, 7-, or 8-level punched tape at a rate of 300 characters per second, while the punch will punch 8-level tape at 60 characters per second.



Punch Card Control Units. These units contain all logic, control and power electronics to make card formats compatible with 6020 formats. One unit is for use with an 800 card-per-minute reader and a 250 card-per-minute punch, while the other unit has a self-contained 200 card-per-minute reader and operates a 100 card-per-minute punch.

Digital Incremental Plotters. Digital incremental plotters are available in four models that offer varied paper size, speeds, and plotting increments. Since the control unit does not require the use of a computer I/O channel, simultaneous plotting and other I/O operations on the same channel are possible.

Special Peripheral Units. Specially designed peripheral units including Analog-to-Digital and Digital-to-Analog Control units increase the versatility of the 6020 by permitting communication with non-digital and "foreign" equipment, thus expanding the user's applications to include on-line and systems control.

ADVANCE 6020

Support

It is the user's desire to get the most out of his computer system as possible, and ASI's Support Program is designed to help you, the user, meet this goal. Not only does the Support Program assist you before, during, and after purchase, but covers the design of the computer system including any special interfacing required. It is the aim of the Support Program to be as complete as possible; to help you in every way. The main features of the Program are as follows:

Pre-purchase Assistance. ASI will meet with your personnel to evaluate your unique problem. Then, a total solution to this problem will be proposed. Included will be the 6020, the options, the peripheral equipment, any special devices, and the software necessary to do the job most efficiently and economically as possible. From the simplest computer installation to a large and complex on-line system, ASI is equipped to design the entire system. You benefit from years of experience and have the assurance that your system will represent the most effective integration of the system's various components.

System Interface Design. For unique user applications, such as on-line installations which require specialized input/output equipment, ASI's Engineering Staff will design the necessary interface units as part of ASI's service to their customers. Then, ASI will fabricate these units, at a normal product price, for your particular system under close supervision by the same engineers that designed them. These engineers, who are naturally quite familiar with the logic and requirements of the 6020, are best qualified to do this important work.

ASI Total System Responsibility. ASI may be contracted to be responsible for the design and installation of all standard and special external devices in the system. One responsibility for the entire system reduces confusion you will have with multiple contractors as well as the confusion between these contractors and the requirements of their various components. The entire system, or as much of it as practical, will be set up and thoroughly tested prior to shipment to your site to assure you it is operational. Let ASI co-ordinate the entire job.

Installation. ASI will be on-site to help with the installation of the equipments. Special attention will be given to the installation of interfacing hardware designed to be used with "foreign" devices. This assistance relieves you of any worry about the proper mating of these two types of hardware. After installation, it will be checked-out to assure you the system is operational. Testing of your particular program and other software by field applications analysts will complete the installation of your system. For highly complex systems, factory programming experts will be on hand for this important phase of installation.

Operator and Programmer Training. Training courses in programming the 6020 and in FORTRAN II and the Symbolic Assembler are available to your programmers. Also, courses are offered to operators in the use of the 6020 and to company management in the most efficient use of their computer system. After installation, classes in advanced systems are made available as well as a programmer's workshop.

Post-purchase Assistance. Assistance to you from ASI continues even after purchase. Trained field applications analysts are available to you on a local level to aid you in the daily running routine of the system and in developing new programs. Factory systems support is available to you from Engineering to modify or expand the hardware in your system, from Applications to find new uses for your computer system, and from Programming to aid you in setting up advanced, complex programs. These services are always available to you whenever you may need them.

User's Group. This organization, made up of users of ASI Computing Systems and sponsored by ASI, provides users an opportunity to share knowledge they have gained in using a digital computing system and exchange programs they have developed.

Maintenance. ASI's staff of competent service personnel, located throughout the country, is available for on-call maintenance of computer hardware at all times. Software maintenance in the form of improvements and additions will be brought to your attention whenever they occur.

ADVANCE 6020

Software

A computing system is only as good as its software. ASI provides a complete software package with the *ADVANCE* Series 6020 which includes a one-pass FORTRAN II Compiler, a one-pass Symbolic Assembler, plus related routines and subroutines. This package insures the user ease of programming.

One-Pass FORTRAN II. The new ASI one-pass complete FORTRAN II Compiler includes subroutine and function statements, arithmetic function statements, and Boolean algebra statements. The one-pass feature provides output in machine language binary from the FORTRAN II program input. "Program Chaining" permits programs whose size exceeds that of the memory in your particular 6020 to be run in segments with one magnetic tape unit.

One-Pass Symbolic Assembler. The new one-pass Symbolic Assembler is an assembly program which permits the use of standard macro coding of such functions as floating point routines and input/output routines. Special features of the Symbolic Assembler include pseudo codes such as ENTRY, COMMON, and LINK which permit flexible linkage, data sharing among subroutines, and program overlay. The Symbolic Assembler provides for the acceptance of source program from cards, paper tape, and magnetic tape. Naturally, such assembler directing codes as RES, OCT, DEC, EQU, ORG, etc., are provided.

Executive Routine. This is a monitor program which allows for the centralized control of program operation. It provides a load-and-go operation without operator intervention with one magnetic tape unit. The operator can specify loading and execution of any program on the master system tape by a simple on-line typewriter directive.

Mathematical Subroutines. ASI provides a complete set of mathematical subroutines including SINE, COSINE, SQ ROOT, EXPONENT, LOG, etc.

Utility Routines. A number of routines allowing tape reproduction, conversion of cards to tape and tape to cards, memory dump, paper tape updating, etc., are also available.

Diagnostic Routines. Diagnostic routines covering both program and hardware checking are available.

ASI

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